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Exercice 1: Heat of Hydration of UHPFRC

Heat of hydration. A semi-adiabatic calorimetry test has been realized on a UHPFRC with detailed composition given in table 1 below (Cvi = thermal capacity of component i):

		UHPFRC	
Component	Cvi [kJ/kg.K]	mi [kg/m^3]	Cvi*mi
Cement	0.76	1410	
Silica fume	0.73	367	
Quartz sand	0.84	80	
Water	4.19	200	
Superplasticizer	4.19	33	
Steel fibres	0.434	707	
		2797	
		ρ [kg/m^3]	Cv[kJ/m^3.K]

1. Determine the thermal capacity Cv of the UHPFRC.
2. Determine the total Heat H_t released by the UHPFRC at 7 days from the adiabatic temperature evolution given in Appendix 1, Figure 1.
3. Determine the theoretical total heat of hydration (full hydration) for the UHPFRC recipe and the degree of hydration and reaction at 7 days with the help of the data given in Appendix 1, tables 1, 2, 3. Discuss the results.
4. If you would like to quantify the effect of silica fume on the hydration process of this UHPFRC, what method(s) would you propose?

References:

Kamen A., Comportement au jeune âge et différé d'un BFUP écrouissant sous les effets thermomecaniques, Doctoral thesis No. 3827, EPFL, Suisse, 246 pp.

Waller V., Relations entre composition, exothermie en cours de prise et résistance en compression des bétons, Thèse ENPC, (2000).

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Appendix 1:

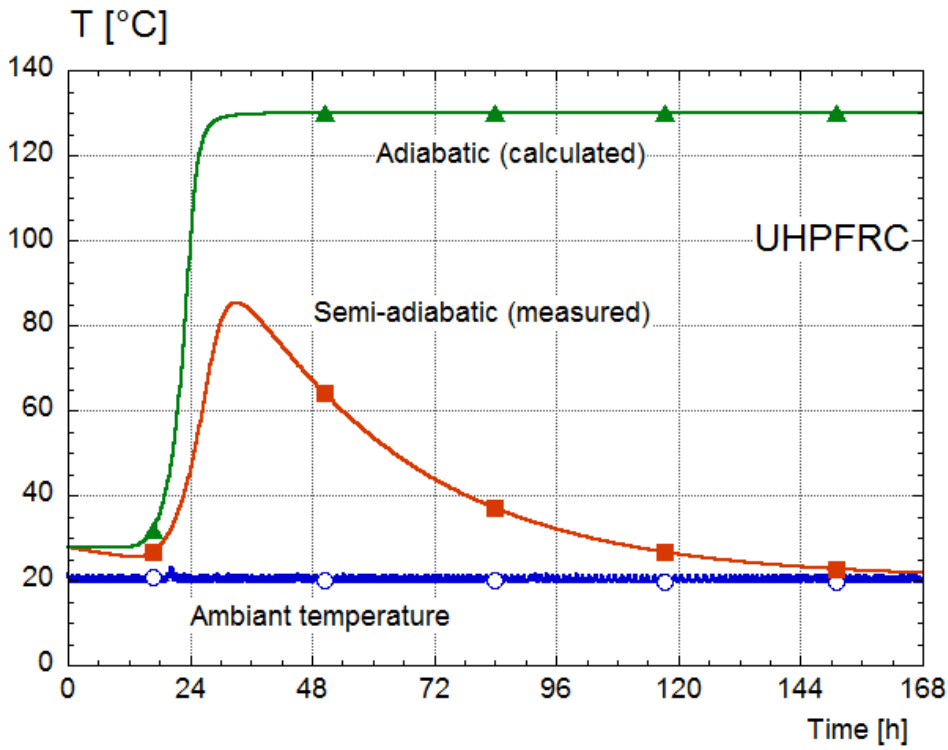

Figure 1

Table 1

Component	Heat [kJ/kg]
C_3S	502
C_2S	260
C_3A	867
C_4AF	419
Silica Fume	780

After Waller (1998)

Table 2 - Cement phases

Phase	(%)
C3S	73.4
C2S	9.9
C3A	3.9
C4AF	5.8
	93.0
Others	7.02

Table 3 - results by SEM image analysis

Age [days]	Degree of hydration of the cement [%]
7	28
90	41